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Integrating Artificial Intelligence into Fuzzy Decision Analytics: A Novel Approach to Mitigating Stereotype Threat in Sustainable Business Environments

Gergely Czukor[1], Hasan Dinçer[2,4], Serkan Eti[3], Serhat Yüksel[2,4], Dragan Pamucar[5,6,*]

[1] Faculty of Social and Human Sciences, İstanbul Bilgi University, İstanbul, Turkey; gergely.czukor@bilgi.edu.tr.
[2] School of Business, Istanbul Medipol University, Istanbul, Turkey; hdincer@medipol.edu.tr; serhatyuksel@medipol.edu.tr.
[3] IMU Vocational School, İstanbul Medipol University, İstanbul, Turkey; seti@medipol.edu.tr.
[4] Department of Economics and Management, Khazar University, Baku, Azerbaijan; hdincer@medipol.edu.tr; serhatyuksel@medipol.edu.tr.
[5] Széchenyi István University, Győr, Hungary; dpamucar@gamil.com.
[6] Department of Applied Mathematical Science, College of Science and Technology, Korea University, Sejong 30019, Republic of Korea; dpamucar@gamil.com.

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Abstract

Preventing the threat of stereotyping is critical for business performance improvements. Because of this situation, businesses must take the necessary precautions. However, these actions have an impact on cost increase for the businesses. The number of studies in the literature performing priority analysis for these factors is quite limited. This situation increases the need for a new study that prioritizes the analysis of these variables. Accordingly, this study aims to evaluate the factors against the stereotype threat in the sustainable business environment. An artificial intelligence model is implemented in the first stage to weigh the experts. In the following stage, selected criteria are evaluated with the help of T-Spherical fuzzy DEMATEL. Thirdly, a comparative analysis was performed using different values. Finally, selected industries are ranked by Spherical Fuzzy RATGOS with respect to the stereotype threat. The weights of the experts can be identified in the analysis process. This situation has a strong contribution to the effectiveness of the findings. It is concluded that training activities are critical to minimizing the threat of stereotypes in companies.

Keywords: Quantum theory, Fuzzy decision-making, Stereotype threat, Sustainable business environment.

1 | Introduction

Stereotype threat is a problem that involves associating an individual with negative prevalent beliefs about their own group. Because of this negative belief, this person fears exhibiting negative behavior toward group

Corresponding Author: dpamucar@gamil.com
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members. This problem causes many problems within the business. Stereotype threat causes individuals' work performance to decrease. An individual's anxiety due to the negative perception of their own group can significantly reduce business motivation [1].

On the other hand, the threat of stereotypes also leads to a decrease in the staff's self-confidence. Owing to this threat, individuals' confidence in their own qualifications decreases. Therefore, employees may not be able to reveal their potential. Another problem with stereotype threat is that individuals miss job opportunities. This threat creates prejudice in the eyes of employers. This situation may lead to negative decisions being made towards these candidates. In summary, stereotype threat increases workplace injustice and reduces employee motivation [2]. Therefore, to improve the performance of businesses, some actions need to be taken to solve this problem.

Various actions can be taken to combat the threat of stereotypes. First, employees' awareness of this problem needs to be increased. In this context, a comprehensive training program should be created. In this way, it is possible to prevent the prejudices of both employers and employees towards this issue. The promotion of positive role models is another important issue [3]. These positive examples make it easier to reduce the negative perception towards a certain group. Positive role models influence other people to see positive things about this group. Mentoring programs are another necessary issue to combat the stereotype threat. Thanks to the support provided within the scope of the mentoring program, it is possible to increase the confidence of employees [4]. Thus, the problem of stereotyping in businesses can be effectively reduced. Improving the corporate culture in the workplace may also be necessary to eliminate this threat. This issue will both increase employees' dependence on the workplace and contribute to breaking down prejudice against employees.

Preventing the threat of stereotyping is essential for the performance of businesses. In this context, businesses must take the necessary precautions. The important point is that these actions will also increase business costs. In other words, practices to be implemented within the scope of combating the threat of stereotypes create new costs for businesses [5]. Excessive costs of these costs can put businesses in financial difficulties. Therefore, financial issues should also be considered when taking action to reduce the threat of stereotypes. In this context, implementing too many measures simultaneously is not financially optimal [6]. However, the number of studies in the literature performing priority analysis for these factors is quite limited.

This study evaluates the factors against the stereotype threat in the sustainable business environment. An artificial intelligence model is created to weigh the expert. Within this context, mathematical models are designed, the machine learning of this model is trained, and the details are tested. In the following stage, selected criteria are weighted with the help of T-Spherical fuzzy DEMATEL. In this process, evaluations are collected, a Decision Matrix (DM) is created, the values are normalized, and the relation matrix is generated. Next, a comparative analysis was performed according to different t-values. Finally, selected industries are ranked by Spherical Fuzzy RATGOS with respect to the stereotype threat. In this scope, a similarity ratio matrix is created, the weighted matrix is generated, and the geometric matrix is constructed. As a result of this condition, the main research questions of this study are demonstrated below:

I. Which factors of stereotype threats in a sustainable business environment have the highest significance weights?

II. Which sectors are mostly affected by the stereotype threats in a negative manner?

This study's main motivation is the need for a comprehensive evaluation to identify the key issues of stereotype threat in the sustainable business environment. There is no consensus in the literature regarding the most critical indicators of this problem. By understanding these significant issues, the problems can be overcome more successfully. Otherwise, companies may not implement the necessary policies for this situation. This issue has a negative influence on the financial performance of the companies. The key reason is that companies have limited budgets. Due to this issue, the most important determinants should be identified. In this context, decision-making models can be taken into consideration. Decision-making models in the literature are criticized by many scholars, such as those who consider experts equal weight. However,

the experts' qualifications can differ due to demographical issues. Considering this missing part, a novel model is created in this study in which the experts' weights can be calculated.

The main contribution of this study is that prior strategies can be determined to manage stereotype threats more effectively by constructing a new model. The effects of stereotype threat in sustainable business environments are examined. This helps to identify the right practices to combat this problem more effectively. In addition, the situation of this problem in different sectors is examined comprehensively. The results guide businesses in developing more effective policies to reduce stereotype threat. Since companies have limited budgets, the most important determinants must be correctly defined. The main superiorities of this model are denoted below:

I. The artificial intelligence technique is adopted for the fuzzy decision-making methodology in the proposed model. Owing to this situation, the weights of the experts can be identified. This condition has a powerful contribution to the effectiveness of the findings. Traditional decision-making models generally evaluate expert opinions with equal weight. However, experts' knowledge level, experience, and demographic characteristics may differ. This may negatively affect the accuracy and reliability of the evaluations. Therefore, calculating the importance of experts' weights is necessary. In summary, calculating expert weights with artificial intelligence applications addresses a criticized deficiency in current decision-making models.

II. Considering the DEMATEL technique also provides some significant advantages. With the help of this technique, causal directions among the indicators can be identified. The main determinants of the stereotype threat may have an impact on each other. Thus, evaluating the causal directions can help to reach more appropriate solutions. DEMATEL technique has certain advantages over other Multi Criteria Decision Making (MCDM) methods, such as Best-Worst Method (BWM), Full Consistency Method (FUCOM) , and Level Based Weight Assessment (LBWA). DEMATEL is superior in identifying and analyzing complex relationships and dependencies between criteria. When weighing the criteria, BWM, FUCOM, and LBWA techniques do not directly consider such interactions. This situation gives the DEMATEL technique a very important advantage in correctly determining complex relationships. Moreover, DEMATEL can determine causal relationships between criteria. Methods such as BWM and FUCOM only determine the order of priority between criteria and do not perform causality analysis.

III. Using the RATGOS methodology to rank selected industries increases the quality of the findings. There are lots of criticisms of existing ranking approaches. RATGOS technique is introduced to handle these problems. RATGOS offers certain advantages over other methods like Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), VIseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), and Additive Ratio Assessment (ARAS). RATGOS uses geometric means when evaluating alternatives. This situation provides more precise results. In contrast, TOPSIS uses a linear distance criterion. Similarly, VIKOR focuses on the proximity of alternatives. In the RATGOS method, analysis with geometric mean can better balance criteria. On the other hand, methods such as VIKOR and TOPSIS generally make certain assumptions to manage uncertainties. This may cause uncertainty in the process and not be managed correctly. Since RATGOS analyzes the relationships between the criteria, it is possible to handle uncertainties more precisely.

A literature review is conducted in the next section. The third part includes the proposed methodology. The results of the analysis are demonstrated in the fourth section. The final sections give information about the discussion and conclusion.

2 | Literature Review

Stereotype threat refers to individuals' fear of involuntarily confirming a negative in-group stereotype [7]. Stereotype threat occurs in members of groups who are negatively stereotyped of their abilities. Academic studies demonstrated that African Americans, Latino Americans, and women underperform on tests of verbal and numerical ability in response to the situational salience of negative stereotypes [8]. For example, completing a demographic survey can have a negative effect on the performances of groups who are

intellectually negatively stereotyped [9]. Stereotype threat can have far-reaching negative consequences. Members of targeted groups may disidentify with the stereotyped domain. Stereotype threat is argued to contribute to the academic achievement gap between American minority groups and European Americans and also between males and females [10].

Researchers suggest that ethnic minorities, women, and employees from low social and economic status can experience stereotype threats in the workplace [11], [12]. The stereotype threat can be generated based on the behavioral-performance ability drawbacks [13]. However, in the application of stereotype threat, researchers define stereotype threat as a type of social identity threat [14]. Accordingly, social identity threats in organizations can affect a wide range of outcomes. These issues include self-advancement behaviors, openness to feedback, professional identification and career aspirations [15], [16]. Some studies confirm that in response to stereotype manipulations, women aspire and identify less with leadership roles [17], [18] and show less interest in careers [19]. Researchers proposed institutional and individual strategies to mitigate stereotype threat effects [20]. Organizations can take steps to reduce work environmental cues of stereotype threat [21]. Identity safety refers to the perception that social group membership is irrelevant to achievement and status in the organization. This goal can be attained by enhancing ethnic and gender diversity in the organization [22]. On the other hand, individual strategies are designed to help stereotyped employees cognitively.

The general performance of negatively stereotyped groups in the organization can be negatively affected by ambient cues in the work. Organizations prioritize impartial principles of assessment in hiring, performance evaluations, and promotions [23]. To achieve equity, organizations are obliged to ensure that majority and minority employees experience the workplace [24]. For example, organizations can minimize the effects of stereotype threat if they avoid using gender categories. Moving demographic questions at the end of the test can improve the test scores of negatively stereotyped groups [25]. The workplace environment can also convey stereotyped messages and interfere with how employees perform generally in the organization. Stereotyped ambient cues are recommended to be replaced with gender-neutral objects and photos of a diverse workforce [26]. These measures reduce the cognitive salience of negative stereotypes associated with social groups.

Underrepresentation in stereotyped positions, such as leadership, can pressure employees from negatively stereotyped groups to disprove negative beliefs about themselves [27]. Increasing diversity can help to eliminate such strains. Enhancing numerical representation increases domain identification [13], reduces their stress, depression, and anxiety [28], and improves their responses to critical feedback [29]. Diversity should be increased in the companies. Hence, stereotyped employees no longer feel discomfort [30]. Additionally, diversity as a value can be included in organizational culture to create a sense of inclusiveness and social support. This situation helps targets cope with stereotype threat [31]. Stereotype threat is identified as depleted leadership talent, which indirectly reduces competitiveness in the market. Accordingly, FTSE 350 companies in the UK have been encouraged to enhance gender diversity in their management boards [32].

Training can be designed to develop individual copying strategies with stereotype threat. Some trainings aim to alter pessimistic beliefs of racial, gender, or SES category membership [33]. Such interventions apply vicarious modeling to increase targets' self-efficacy [34]. Another method includes social-belonging interventions designed to help people develop a positive approach toward struggles [35]. Employees learn personal accounts of individuals who, early on, experienced hardships, such as loneliness. Employees are further instructed to explain how their stories reflect the same experiences. Social belonging interventions have had remarkable implications for academic performance [36]. Training can also be directed towards peers. Managers are encouraged to give critical feedback by emphasizing high standards [37].

In sum, organizations can improve how members of negatively stereotyped groups psychologically experience the workplace. This situation can minimize the negative implications of stereotype threats on targeted employees' performances. Training, diversity, and modifying ambient cues to ensure equity in assessment are industrial and organizational psychology tools. Practices within the scope of combating the threat of

stereotypes create new costs for businesses. Excessive costs of these costs can put businesses in financial difficulties. Because of this issue, financial issues should also be considered while taking action to minimize the threat of stereotypes. Within this framework, it is not financially optimal to implement too many different actions simultaneously. Hence, it is necessary to carry out a comprehensive analysis and identify the problems that affect this problem the most. However, the number of studies in the literature performing priority analysis for these factors is quite limited. This situation demonstrates the main missing part in the literature.

3 | Methodology

Ranking the threats according to significance has become essential [38], [39]. In this process, the DEMATEL method is taken into consideration [40]. Fuzzy numbers are integrated with this technique to minimize the uncertainties in expert assessments [41]. This situation helps to make more effective evaluations [42]. A T-Spherical fuzzy set is one of the fuzzy number sets. This study uses the T-Spherical Fuzzy DEMATEL approach to reach this objective [43]. In the next stage, sectors are ranked based on the stereotype threat by the RATGOS method. The sequential stages of the model are illustrated in *Fig. 1*.

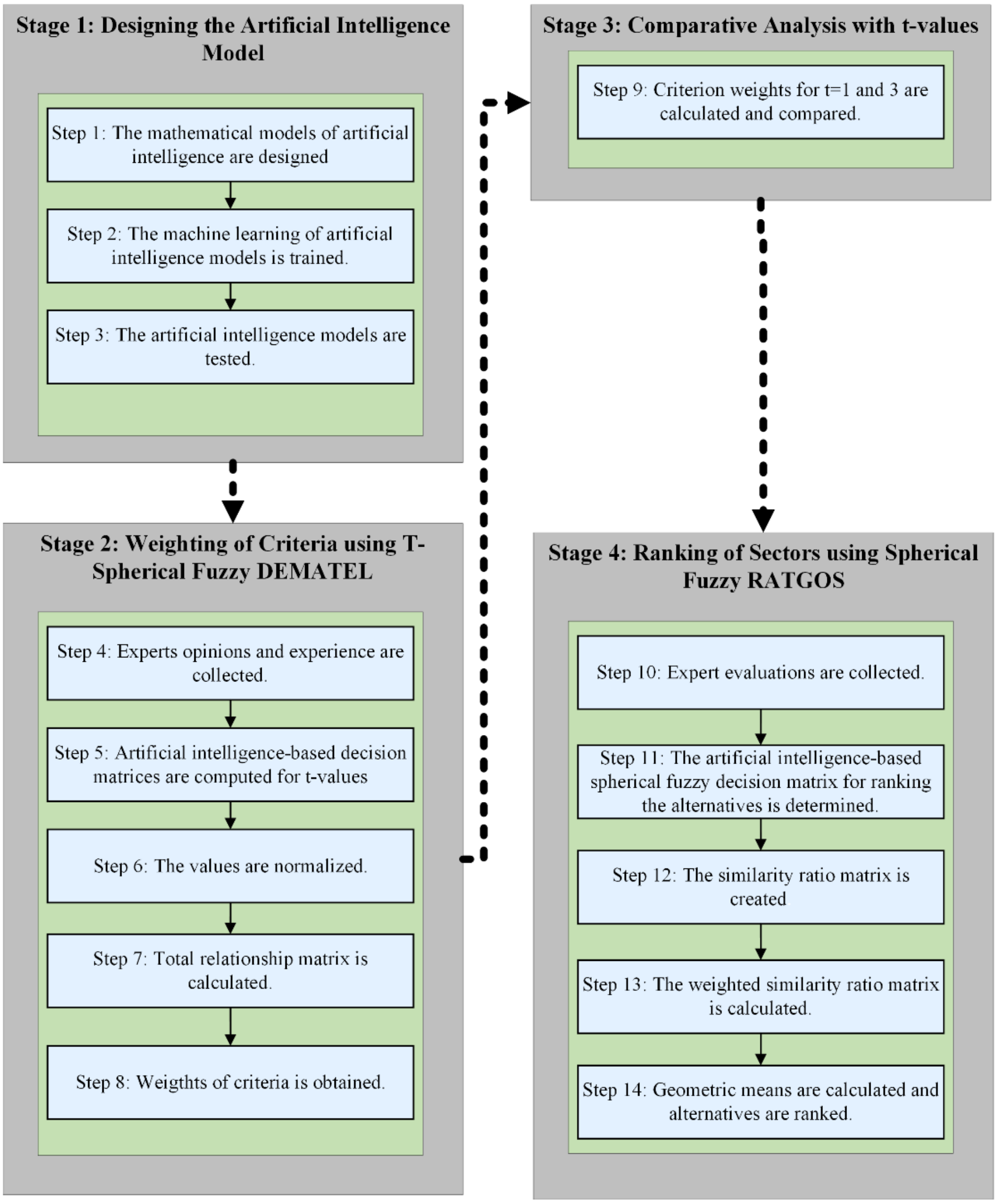

Fig. 1. Flowchart.

The calculations in the steps of the flowchart are presented under the following subtitles.

3.1 | Artificial Intelligence-based Decision Matrix

Artificial intelligence models enable machines to simulate human-like intelligence by learning, reasoning, and decision-making [44]. These methods continue to evolve with advancements in computing power [45]. The Sigmoid function, characterized by a value range between 0 and 1, allows for seamless integration into fuzzy numbers [46]. *Eq. (1)* depicts the Sigmoid function.

$$S(x) = \frac{1}{1 + e^{-ax}}. \tag{1}$$

The intricacies of the Adam algorithm are elucidated in *Eqs. (2)-(6)* [47].

$$W_{t+1} = W_t - \frac{a}{\sqrt{\hat{S}_t + \epsilon}} \hat{V}_t. \tag{2}$$

$$\hat{V}_t = \frac{V_t}{1 - \beta_1^t}. \tag{3}$$

$$\hat{S}_t = \frac{S_t}{1 - \beta_2^t}. \tag{4}$$

$$V_t = \beta_1 V_{t-1} + (1 - \beta_1) \frac{\partial L}{\partial w_t}. \tag{5}$$

$$S_t = \beta_2 S_{t-1} + (1 - \beta_2) \left[\frac{\partial L}{\partial w_t}\right]^2. \tag{6}$$

Step 1 involves the design of the artificial intelligence model. In this stage, *Eq. (1)* is incorporated into the software [48]. Furthermore, for optimization purposes, the Adam algorithm has been selected. In *Step 2*, the developed artificial intelligence model undergoes training. The output variable of the model (SWAM) is derived through the application of *Eqs. (7)* and *(8)*. Notably, since the t value is variable, the output variable is recalculated for each t value, and the training process is repeated.

$$SWAM = \left\{ \left[1 - \prod_{i=1}^{n} (1 - \mu_i^t)^{w_i}\right]^{\frac{1}{t}}, \prod_{i=1}^{n} v_i^{w_i}, \left[\prod_{i=1}^{n} (1 - \mu_i^t)^{w_i} - \prod_{i=1}^{n} (1 - \mu_i^t - \pi_i^t)^{w_i}\right]^{\frac{1}{t}} \right\}. \tag{7}$$

$$w_i = \frac{d_i}{\sum_{i=1}^{n} d_i}. \tag{8}$$

Table 1. Linguistic variables.

Terms	μ	v	π
Strong	0,85	0,15	0,45
Moderate	0,6	0,2	0,35
Weak	0,35	0,25	0,25
No Influence	0	0,3	0,15

In *Step 3*, the model's validity is subjected to testing. The calculation of the MSE value is shown in *Eq. (9)*.

$$MSE = \frac{1}{m} \sum_{i=1}^{m} (Y_i - \hat{Y}_i)^2. \tag{9}$$

In this process, Y represents the value in the train data and $\hat{Y}$ is the output score from the model. m is the number of data.

3.2 | T-Spherical Fuzzy DEMATEL

The steps of the T-Spherical Fuzzy DEMATEL method are summarized below [49], [50]. In *Step 1*, an expert team is assembled. Next, an artificial intelligence-based DM is derived. Evaluations and experience durations are considered as inputs [51]. The resulting DM is represented by *Eq. (10).* It is important to note that distinct decision matrices are generated for each t value at this stage.

$$\mathrm{DM} = \begin{bmatrix} - & \cdots & (\mu_{1n}, v_{1n}, \pi_{1n}) \\ \vdots & \ddots & \vdots \\ (\mu_{n1}, v_{n1}, \pi_{n1}) & \cdots & - \end{bmatrix}. \tag{10}$$

Step 3 divides the T-Spherical fuzzy DM into submatrices for each component. Then, each submatrix is Normalized (NM) with *Eqs. (11)* and *(12).*

$$\mathrm{NM} = g * \mathrm{DM}. \tag{11}$$

$$g = \min\left[\frac{1}{\max\limits_{i} \sum_{j=1}^{n} \left|dm_{ij}\right|}, \frac{1}{\max\limits_{j} \sum_{i=1}^{n} \left|dm_{ij}\right|}\right]. \tag{12}$$

In *Step 4*, the Total Relationship Matrix (TRM) components are calculated with *Eq. (13).*

$$\mathrm{TRM} = \mathrm{NM} * (1 - \mathrm{NM})^{-1}. \tag{13}$$

After that, Euclidean normalization is applied [52]. Subsequently, the values are defuzzied by *Eq. (14).*

$$\mathrm{Score} = (2\mu - \pi)^{t} - (v - \pi)^{t}. \tag{14}$$

In this scope, μ^t, v^t and π^t represent the components of the Spherical fuzzy TRM [53]. In *Step 5*, the weights (wgh) of the criteria are computed via *Eqs. (15)-(17).*

$$D_i = \sum_{j=1}^{n} trm_{ij}. \tag{15}$$

$$R_j = \sum_{i=1}^{n} trm_{ij}. \tag{16}$$

$$wgh_i = \frac{D_i + R_i}{\sum_{i=1}^{n}(D_i + R_i)}. \tag{17}$$

In these equations, D and R represent the sums of the row and column values. The outcome of the calculation indicates that a larger w value corresponds to a greater importance of the criterion [54].

In *Step 6*, a comparative analysis is performed. Analyzes are performed again at different degrees. The results are compared with each other. In this way, the consistency of the weights is observed.

3.3 | Spherical Fuzzy RATGOS

The RATGOS method ranks alternatives with a criteria set. *Table 2* demonstrates the scales.

Table 2. Linguistic variables for ranking.

Terms	μ	v	π
Absolutely Low	0.1	0.9	0
Big Low	0.2	0.8	0.1
Low	0.3	0.7	0.2
Small Low	0.4	0.6	0.3
Equal	0.5	0.5	0.4
Small More	0.6	0.4	0.3
More Importance	0.7	0.3	0.2
High More	0.8	0.2	0.1
Great More	0.9	0.1	0

In *Step 2*, the artificial intelligence-based spherical fuzzy DM (Z) is depicted in *Eq. (18)*.

$$Z = \begin{bmatrix} (\mu_{11}, v_{11}, \pi_{11}) & \cdots & (\mu_{1n}, v_{1n}, \pi_{1n}) \\ \vdots & \ddots & \vdots \\ (\mu_{m1}, v_{m1}, \pi_{m1}) & \cdots & (\mu_{mn}, v_{mn}, \pi_{mn}) \end{bmatrix}. \quad \textbf{(18)}$$

Step 3 involves creating the similarity ratio matrix (B). Thus, unit size is removed, and similarities to the solution are determined at the micro level. First, the optimal values for each criterion are obtained with *Eqs. (19)-(20)*.

$$\text{optimal} = \{(\mu, v, \pi) | \max(S(Z_i)\} \text{ for benefit criteria.} \quad \textbf{(19)}$$

$$\text{optimal} = \{(\mu, v, \pi) | \min(S(Z_i)\} \text{ for cost criteria.} \quad \textbf{(20)}$$

S(Z) is the formulation in *Eq. (14)*. Later, DM values are divided by the optimal value via *Eq. (21)*. However, since division is not defined in Spherical fuzzy sets, the 1/S(optimal) value is multiplied by the Z matrix with the help of *Eq. (22)*.

$$\tilde{b}_{ij} = \frac{1}{S(\text{optimal})} \widetilde{z_{ij}}. \quad \textbf{(21)}$$

$$\lambda\tilde{A} = \left\{ \left(1 - \left(1 - \mu_A^2\right)^{\lambda}\right)^{0,5}, v_A^{\lambda}, \left(\left(1 - \mu_A^2\right)^{\lambda} - \left(1 - \mu_A^2 - \pi_A^2\right)^{\lambda}\right)^{0,5} \right\}. \quad \textbf{(22)}$$

The multiplication in *Eq. (23)* is computed in *Eq. (22)*.

$$F = WB. \quad \textbf{(23)}$$

In this process, W is the weight of the criteria. This ensures that the priorities of the criteria are included in the analysis. In *Step 5*, the Geometric (Geo) mean of the rows of the F matrix is computed to rank the alternatives by *Eqs. (24)-(25)*. Finally, the spherical fuzzy geometric mean values are defuzzied by *Eq. (14)*.

$$\text{Geo} = \sqrt[n]{\prod_{j=1}^{n} f_{ij}}. \quad \textbf{(24)}$$

$$\text{SGM}(A_1, A_2, \ldots, A_n) = \left\{ \prod_{i=1}^{n} \mu_{A_i}^{\frac{1}{n}}, \left[1 - \prod_{i=1}^{n} \left(1 - v_{A_i}^2\right)^{\frac{1}{n}}\right]^{0,5}, \left[\prod_{i=1}^{n} \left(1 - v_{A_i}^2\right)^{\frac{1}{n}} - \prod_{i=1}^{n} \left(1 - v_{A_i}^2 - \pi_{A_i}^2\right)^{\frac{1}{n}}\right]^{0,5} \right\}. \quad \textbf{(25)}$$

4 | Analysis Results

The findings are given in the following subsections.

4.1 | Designing the Expert Significance

In this section, MSE values are computed to design expert significance. The MSE values for the three models are provided in *Table 3*.

Table 3. MSE values for models.

Models	MSE Values
t=1	0.0049
t=2	0.0036
t=3	0.0137

These values are near zero. This situation indicates a high level of success for these models.

4.2 | Identifying Factors Stereotype Threats in a Sustainable Business Environment

By examining the literature, factors that stereotype threats in a sustainable business environment are identified. Recent studies in this area have been taken into consideration. With the help of this issue, a new criteria set is created that consists of 8 different items. These eight criteria and their codes used in the study are given in *Table 4*.

Table 4. Factors stereotype threats in SBE.

Criteria	Code
Diversity among the members	DIAM
Employee engagement	EMEN
Career opportunities	COPP
Performance assessment	PASS
Training activities	TACT
Creativity	CREAT
Mentorship	MENT
Stress Management	SMNG

4.3 | Weighting the Factors Stereotype Threats Using T-Spherical Fuzzy DEMATEL

In *Step 4*, an expert team is formed to assign weights to the eight criteria identified through the T-Spherical Fuzzy DEMATEL method. The team members have experience periods of 25, 27, and 21 years, respectively. The selection of team members considers their academic studies in their respective fields. The opinions of the experts are detailed in *Table 5*.

Table 5. Experts opinions.

Expert 1								
	DIAM	**EMEN**	**COPP**	**PASS**	**TACT**	**CREAT**	**MENT**	**SMNG**
DIAM		1	2	2	2	3	1	2
EMEN	3		2	3	2	4	1	2
COPP	2	2		1	3	3	4	2
PASS	3	2	3		1	4	1	2
TACT	4	4	4	3		4	3	4
CREAT	2	3	2	3	3		3	3
MENT	4	4	4	3	3	3		4
SMNG	3	2	1	2	2	3	3	

Table 5. Continued.

Expert 2								
	DIAM	**EMEN**	**COPP**	**PASS**	**TACT**	**CREAT**	**MENT**	**SMNG**
DIAM		1	2	2	2	3	1	2
EMEN	3		2	3	2	4	1	2
COPP	2	2		1	3	3	4	2
PASS	3	2	3		3	4	1	2
TACT	4	4	4	3		4	3	4
CREAT	2	3	2	3	3		3	3
MENT	4	4	4	3	3	3		4
SMNG	3	2	1	2	2	3	3	
Expert 3								
	DIAM	**EMEN**	**COPP**	**PASS**	**TACT**	**CREAT**	**MENT**	**SMNG**
DIAM		2	2	3	1	2	3	2
EMEN	3		1	1	1	2	3	2
COPP	2	2		1	3	3	4	2
PASS	3	4	3		2	4	1	2
TACT	4	4	3	4		4	3	4
CREAT	2	2	2	2	3		3	2
MENT	4	1	4	3	4	4		3
SMNG	3	2	1	2	2	4	1	

In *Step 5*, artificial intelligence-based decision matrices are generated. The fuzzy DM produced for t=2 is outlined in *Table 6*. Also, the decision matrices for other t values are provided in *Table A1* in the Appendix.

Table 6. Fuzzy DM for t=2.

	DIAM			**EMEN**			**COPP**			**PASS**			**TACT**			**CREAT**			**MENT**			**SMNG**		
DIAM	0.00	0.00	0.00	0.19	0.30	0.20	0.46	0.24	0.34	0.61	0.21	0.41	0.26	0.28	0.24	0.68	0.20	0.45	0.28	0.27	0.25	0.46	0.24	0.34
EMEN	0.72	0.19	0.47	0.00	0.00	0.00	0.26	0.28	0.24	0.59	0.22	0.40	0.26	0.28	0.24	0.73	0.19	0.47	0.28	0.27	0.25	0.46	0.24	0.34
COPP	0.46	0.24	0.34	0.46	0.24	0.34	0.00	0.00	0.00	0.14	0.31	0.17	0.72	0.19	0.47	0.72	0.19	0.47	0.75	0.18	0.49	0.46	0.24	0.34
PASS	0.72	0.19	0.47	0.69	0.20	0.45	0.72	0.19	0.47	0.00	0.00	0.00	0.41	0.25	0.31	0.75	0.18	0.49	0.14	0.31	0.17	0.46	0.24	0.34
TACT	0.75	0.18	0.49	0.75	0.18	0.49	0.74	0.19	0.48	0.74	0.19	0.48	0.00	0.00	0.00	0.75	0.18	0.49	0.72	0.19	0.47	0.75	0.18	0.49
CREAT	0.46	0.24	0.34	0.68	0.20	0.45	0.46	0.24	0.34	0.68	0.20	0.45	0.72	0.19	0.47	0.00	.00	.00	0.72	0.19	0.47	0.68	0.20	0.45
MENT	0.75	0.18	0.49	0.70	0.19	0.46	0.75	0.18	0.49	0.72	0.19	0.47	0.74	0.19	0.48	0.74	0.19	0.48	.00	.00	.00	0.74	0.19	0.48
SMNG	0.72	0.19	0.47	0.46	0.24	0.34	0.14	0.31	0.17	0.46	0.24	0.34	0.46	0.24	0.34	0.74	0.19	0.48	0.59	0.22	0.40	.00	.00	.00

In *Step 6*, the submatrices are normalized via *Eqs. (11)* and *(12)*.. Total relationship submatrices are computed using *Eq. (13)*. Subsequently, the defuzzied total relationship matrix is derived by *Eq. (14)*. *Step 8* involves the determination of criterion weights. The values for D, R, and W of the criteria are presented in *Table 7*.

Table 7. D, R, and W values of the criteria.

Criteria	**D**	**R**	**W**
DIAM	0.360	0.962	0.086
EMEN	0.491	0.951	0.094
COPP	0.899	0.950	0.121
PASS	0.815	0.957	0.116
TACT	1.571	0.959	0.165
CREAT	1.256	0.968	0.145
MENT	1.552	0.960	0.164
SMNG	0.719	0.955	0.109

The factors are ranked from largest to smallest. The ranking results of the criteria are given in *Fig. 2*.

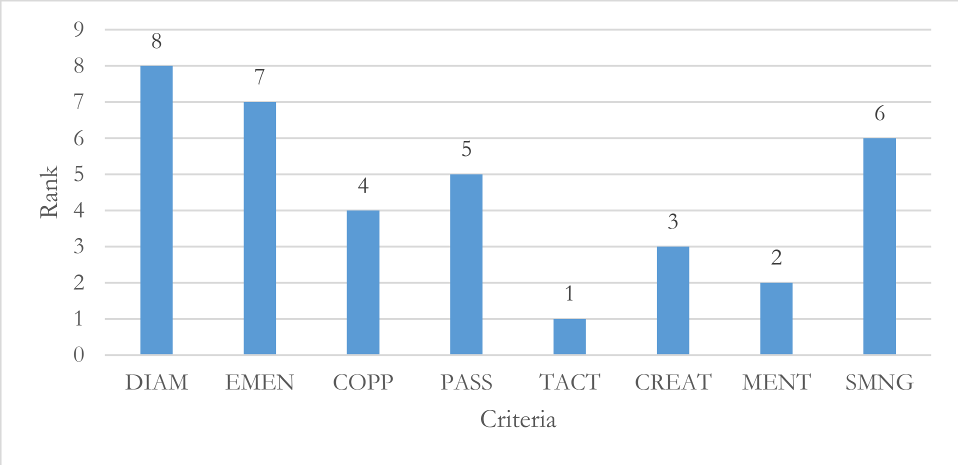

Fig. 2. Ranking of criteria.

It is concluded that the most important criterion is training activities. Similarly, the second important factor in this framework is mentorship. However, employee engagement and diversity among the members have the lowest weights regarding the stereotype threat.

4.4 | Comparative Analysis with other t-Values

In *Step 9*, a comparative evaluation is conducted. The comparative results are visually represented in *Fig. 3*.

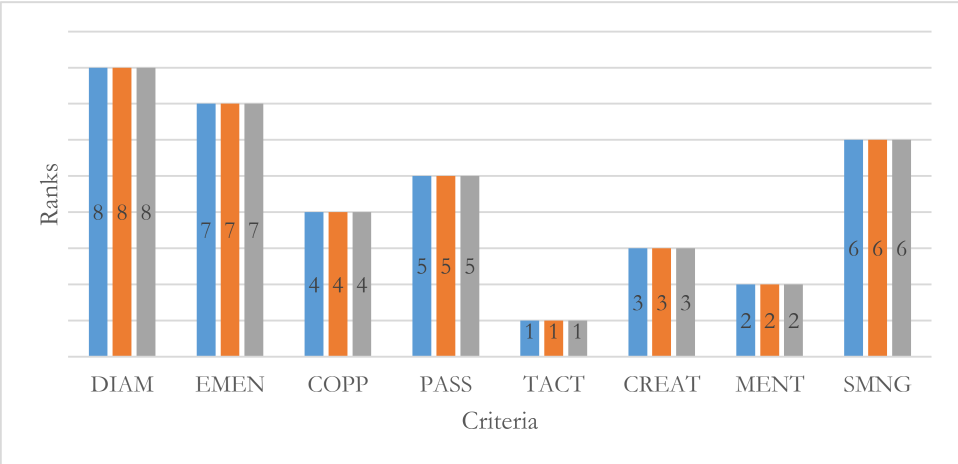

Fig. 3. Comparative analysis result

It is seen that similar ranking results are achieved for the three different t values. The correlation values are found as 0.95 and 0.98.

4.5 | Ranking of Sectors Using Spherical Fuzzy RATGOS

In *Step 10*, expert opinions are collected from the expert team. These evaluations are shown in *Table 8*.

Table 8. Evaluation of sectors.

Expert 1								
	DIAM	**EMEN**	**COPP**	**PASS**	**TACT**	**CREAT**	**MENT**	**SMNG**
Education	9	9	8	9	7	8	9	9
Agriculture	3	9	4	7	5	5	8	2
Finance	9	6	9	7	8	8	2	9
Health	6	3	9	6	9	9	5	4
Tourism	3	2	4	4	4	6	1	4
Textile	7	2	5	3	7	2	9	2
Construction	9	5	1	6	8	4	6	5
Technology	6	5	6	6	9	2	6	2
Expert 2								
	DIAM	**EMEN**	**COPP**	**PASS**	**TACT**	**CREAT**	**MENT**	**SMNG**
Education	8	8	9	8	9	9	8	9
Agriculture	6	1	3	5	1	6	5	4
Finance	8	7	5	5	1	9	1	6
Health	6	9	3	7	1	4	9	7
Tourism	1	8	4	1	8	2	1	2
Textile	5	3	4	5	5	6	8	9
Construction	6	1	7	2	3	1	9	7
Technology	3	2	8	1	2	5	8	9
Expert 3								
	DIAM	**EMEN**	**COPP**	**PASS**	**TACT**	**CREAT**	**MENT**	**SMNG**
Education	8	7	8	9	9	8	9	9
Agriculture	4	6	8	8	3	4	2	9
Finance	6	6	8	1	2	2	6	5
Health	7	3	1	2	4	8	8	3
Tourism	5	4	8	5	4	1	4	3
Textile	1	8	7	2	6	5	7	6
Construction	5	9	3	8	1	5	1	1
Technology	4	3	4	7	9	4	6	1

In *Step 11*, the artificial intelligence-based spherical fuzzy DM is determined. In this process, learning success is evaluated with the MSE value. Finally, the experts' actual opinions and experience periods are given as input to the model. The spherical fuzzy DM is denoted in *Table 9*.

Table 9. Z matrix.

	DIAM			EMEN			COPP			PASS			TACT			CREAT			MENT			SMNG		
Education	0.81	0.20	0.17	0.80	0.21	0.17	0.82	0.19	0.17	0.82	0.19	0.17	0.82	0.19	0.17	0.82	0.19	0.17	0.82	0.19	0.17	0.84	0.17	0.16
Agriculture	0.48	0.55	0.21	0.67	0.35	0.19	0.58	0.45	0.20	0.67	0.35	0.19	0.34	0.69	0.23	0.52	0.51	0.20	0.64	0.38	0.19	0.63	0.39	0.19
Finance	0.79	0.22	0.17	0.65	0.37	0.19	0.78	0.24	0.17	0.56	0.47	0.20	0.54	0.49	0.20	0.76	0.25	0.18	0.38	0.64	0.22	0.76	0.26	0.18
Health	0.61	0.41	0.19	0.66	0.36	0.19	0.65	0.38	0.19	0.59	0.44	0.20	0.63	0.39	0.19	0.76	0.25	0.18	0.78	0.24	0.17	0.56	0.47	0.20
Tourism	0.33	0.70	0.23	0.58	0.44	0.20	0.58	0.45	0.20	0.36	0.66	0.22	0.64	0.39	0.19	0.40	0.63	0.22	0.23	0.79	0.24	0.29	0.74	0.23
Textile	0.56	0.47	0.20	0.55	0.47	0.20	0.53	0.50	0.20	0.37	0.66	0.22	0.62	0.41	0.19	0.48	0.55	0.21	0.80	0.21	0.17	0.67	0.35	0.19
Construction	0.76	0.26	0.18	0.67	0.35	0.19	0.48	0.54	0.21	0.61	0.41	0.19	0.59	0.44	0.20	0.36	0.66	0.22	0.72	0.30	0.18	0.56	0.47	0.20
Technology	0.47	0.56	0.21	0.36	0.67	0.22	0.68	0.34	0.19	0.55	0.48	0.20	0.77	0.25	0.18	0.39	0.64	0.22	0.71	0.31	0.18	0.61	0.41	0.19

Spherical fuzzy geometric means are defuzzied with *Eq. (14)*. The values are shown in *Table 10*.

Table 10. Geometric means.

Sectors	Geo			Defuzzied
Education	0.246	0.912	0.069	-0.679
Agriculture	0.000	0.944	0.065	-0.768
Finance	0.173	0.946	0.063	-0.768
Health	0.176	0.945	0.060	-0.770
Tourism	0.101	0.973	0.062	-0.829
Textile	0.147	0.957	0.060	-0.797
Construction	0.153	0.954	0.061	-0.790
Technology	0.143	0.958	0.061	-0.798

It is identified that the largest defuzzied geometric mean value is -0.679. This situation shows that the most successful sector is education. The ranking results are given in *Fig. 4*.

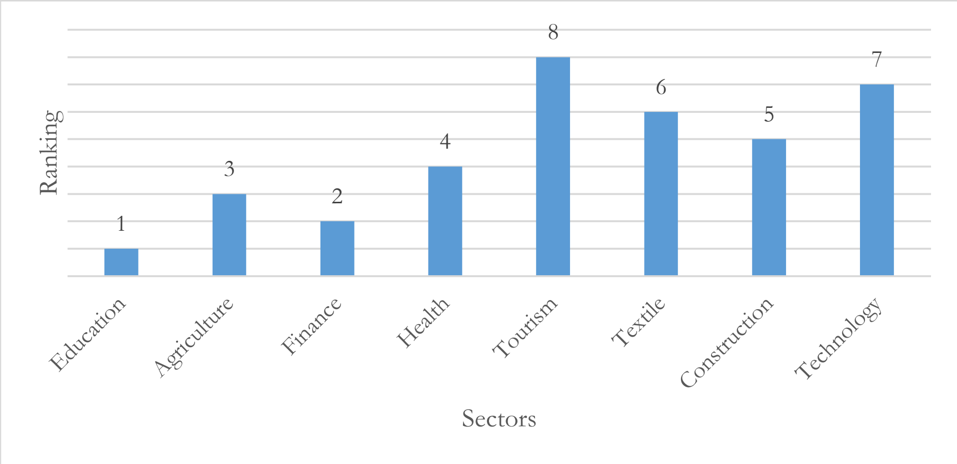

Fig. 4. Ranking of sectors.

4.6 | Comparative Ranking for Robustness.

A second analysis is performed to check the results' robustness, reliability, and validity. A sensitivity analysis was also conducted to reach this purpose. In this process, the ARAS methodology is taken into consideration. The results are presented in *Fig. 5*.

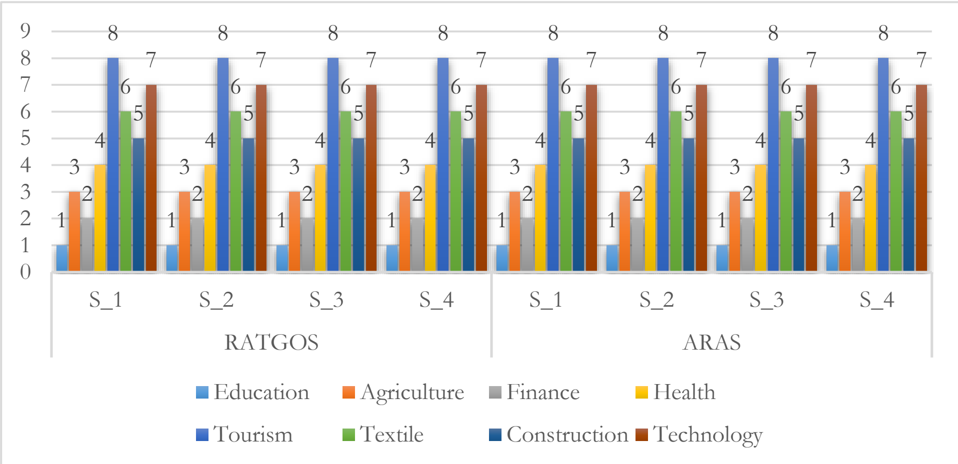

Fig. 5. Comparative ranking.

Fig. 5 denotes that the results are the same. This situation gives information about the validity of the findings.

5 | Discussion

It has been concluded that education is very important in minimizing the threat of stereotypes. This threat is mainly related to people's prejudices. Therefore, education is very necessary for changes to occur in this regard. Training provided is very important in understanding how these threats first emerged. This situation can help individuals give up these prejudices.

On the other hand, thanks to comprehensive training, people can more clearly understand that these prejudices are meaningless. This situation psychologically supports the elimination of these prejudices. In addition to these factors, training also enables people to empathize with others. This issue helps to understand how difficult the threat of stereotypes puts people clearly. This contributes to a significant reduction in this bias.

On the other hand, Gilet et al. [55] stated that people's knowledge about stereotype threat increases thanks to training. In this way, it can be understood that these prejudices greatly harm the performance of businesses. Appel and Weber [56] indicated that this situation allows both managers and other employees to be more sensitive to this problem. Seo and Lee [57] mentioned that different stereotypes can emerge. On the other hand, according to Totonchi et al. [58], it should be clearly explained how stereotype threats will negatively affect company performance. The power of positive role models should also be seriously emphasized in these trainings.

Mentoring also plays an important role in the process of minimizing the threat of stereotypes. One of the biggest advantages of mentoring is that it creates an environment of trust within the business. Individuals who face the threat of stereotypes come under psychological pressure. These people can feel safer if they tell their problems to their mentor. Stelter et al. [59] discussed that thanks to the mentor, the depth of the problem can be understood by the entire business management. In other words, the mentoring system increases awareness of the stereotype threat within the business. This situation contributes significantly to solving this problem. Vargas et al. [60] defined that thanks to the mentoring system, feedback can be obtained regarding the success of the actions taken against the stereotype threat. This helps to implement more effective strategies to solve the problem. Some issues should be considered when designing mentoring programs to minimize the threat of stereotypes. First, the mentoring program should be quite comprehensive [61]. On the other hand, regular feedback should be provided in mentoring programs [62]. This situation provides detailed information about the operational performance of the mentoring system.

Stereotype threat is identified as an important issue in the education sector. This problem can have a very negative impact on students' performance and academic success. This situation also reduces students' motivation for education and learning. This situation causes the success in the education sector to decrease. On the other hand, students' classroom interactions are also negatively affected by stereotype threat. Students under this threat may avoid interacting with their peers and teachers. This situation causes the performance of these people to decrease. Stereotype threat causes increased test anxiety. As a result, students' success may drop significantly.

Furthermore, stereotype threat negatively affects students' career choices. For these reasons, combating the threat of stereotypes in the education sector is more important than in other sectors. The main advantage of Spherical fuzzy sets is that a wider range of data sets can be considered. This situation has a positive influence on the management of uncertainties in a more effective way. Intuitionistic, Pythagorean, picture and hesitant fuzzy sets are also used for this purpose in the literature [63–65]. Each fuzzy set has some specific advantages [66–69].

6 | Conclusion

6.1 | Concluding Remarks

The help of T-Spherical fuzzy DEMATEL evaluates selected criteria. Next, a comparative analysis was performed using different values. Finally, selected industries are ranked by Spherical Fuzzy RATGOS with respect to the stereotype threat. It is concluded that training activities play the most critical role in minimizing stereotype threat in companies. Similarly, the second important factor in this framework is the mentorship. Conversely, employee engagement and diversity among the members have the lowest weight regarding the stereotype threat in the sustainable business environment. In addition, a comparative examination was performed using different values. It is determined that the results are similar for different t values. This situation gives information about the reliability and coherency of the proposed model. Furthermore, education is found to be the most critical industry regarding this problem.

6.2 | Policy Implications

It is determined that educational activities play the most critical role in minimizing the threat of stereotypes. Based on this result, it is appropriate to implement some policies and strategies. Regular training programs are one of the most critical issues in this context. In this context, both mandatory training for all employees and special comprehensive training for managers can be provided. This increases the awareness of all employees about the importance of this threat. Similarly, with these trainings, managers can understand more clearly what kind of measures they can take to combat this problem. Thanks to this program, employees are close to a manager they can consult when they encounter a possible stereotype threat. Moreover, communication channels should be created where employees can easily express their thoughts. Similarly, it would be appropriate to conduct surveys to measure employee satisfaction periodically. In this way, detecting a possible problem at an early stage is possible. Analysis results are computed according to different t values. This comparative evaluation provides an opportunity to check the reliability of the findings. However, stereotype threat negatively influences some important industries, such as energy and banking. In these industries, innovative strategies should be provided to increase the effectiveness. Because of this issue, stereotype threat creates a barrier to performance improvement. Thus, these industries can be evaluated, specifically in future studies.

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Author Contributaion

Conceptualization, G.C., H.D and S.Y.; Methodology, H.D., S.E. and D.P.; Software, S.E. and D.P.; Validation, G.C., H.D and S.Y.; formal analysis, S.E.; investigation, H.D., S.E. and D.P.; resources, S.Y.; data maintenance, G.C., H.D and S.Y.; writing-creating the initial design, G.C., H.D and S.Y.; writing-reviewing and editing, S.E. and D.P.; visualization, S.E. and D.P.; monitoring, H.D., S.E. and D.P.; project management, G.C., H.D and S.Y.; funding procurement, G.C., H.D and S.Y. All authors have read and agreed to the published version of the manuscript.

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No data is used in this study.

Conflicts of Interest

The authors declare no conflict of interest.

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Appendix

Table A1. Fuzzy decision matrix for t=1 and t=3.

t=3	DIAM			EMEN			COPP			PASS			TACT			CREAT			MENT			SMNG		
DIAM	0.00	0.00	0.00	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36
EMEN	0.59	0.22	0.36	0.00	0.00	0.00	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36
COPP	0.59	0.22	0.36	0.59	0.22	0.36	0.00	0.00	0.00	0.58	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36
PASS	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.00	0.00	0.00	0.59	0.22	0.36	0.59	0.22	0.36	0.58	0.22	0.36	0.59	0.22	0.36
TACT	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.00	0.00	0.00	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36
CREAT	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.00	0.00	0.00	0.59	0.22	0.36	0.59	0.22	0.36
MENT	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.00	0.00	0.00	0.59	0.22	0.36
SMNG	0.59	0.22	0.36	0.59	0.22	0.36	0.58	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.59	0.22	0.36	0.00	0.00	0.00
t=1	**DIAM**			**EMEN**			**COPP**			**PASS**			**TACT**			**CREAT**			**MENT**			**SMNG**		
DIAM	0.00	0.00	0.00	0.39	0.26	0.28	0.53	0.23	0.35	0.60	0.22	0.38	0.42	0.25	0.30	0.64	0.21	0.40	0.43	0.25	0.30	0.53	0.23	0.35
EMEN	0.66	0.20	0.41	0.00	0.00	0.00	0.42	0.25	0.30	0.59	0.22	0.38	0.42	0.25	0.30	0.66	0.20	0.42	0.43	0.25	0.30	0.53	0.23	0.35
COPP	0.53	0.23	0.35	0.53	0.23	0.35	0.00	0.00	0.00	0.36	0.27	0.26	0.66	0.20	0.41	0.66	0.20	0.41	0.67	0.20	0.42	0.53	0.23	0.35
PASS	0.66	0.20	0.41	0.64	0.21	0.40	0.66	0.20	0.41	0.00	0.00	0.00	0.50	0.23	0.33	0.67	0.20	0.42	0.36	0.27	0.26	0.53	0.23	0.35
TACT	0.67	0.20	0.42	0.67	0.20	0.42	0.67	0.20	0.42	0.67	0.20	0.42	0.00	0.00	0.00	0.67	0.20	0.42	0.66	0.20	0.41	0.67	0.20	0.42
CREAT	0.53	0.23	0.35	0.64	0.21	0.40	0.53	0.23	0.35	0.64	0.21	0.40	0.66	0.20	0.41	0.00	0.00	0.00	0.66	0.20	0.41	0.64	0.21	0.40
MENT	0.67	0.20	0.42	0.65	0.21	0.41	0.67	0.20	0.42	0.66	0.20	0.41	0.67	0.20	0.42	0.67	0.20	0.42	0.00	0.00	0.00	0.67	0.20	0.42
SMNG	0.66	0.20	0.41	0.53	0.23	0.35	0.36	0.27	0.26	0.53	0.23	0.35	0.53	0.23	0.35	0.67	0.20	0.42	0.59	0.22	0.38	0.00	0.00	0.00